INTRODUCTION: Many studies in the recent literature have focused upon the effects of a medializing calcaneal osteotomy (MCO) upon the surrounding joints and soft tissues in the foot and ankle (1-4). The effects of this procedure upon plantar foot pressures and the Achilles tendon warrant investigation as many patients who undergo this procedure to correct flat foot deformity have a coexisting contracture of the Achilles tendon and complain of lateral forefoot pain postoperatively. In a recent article from our group (5) a medializing calcaneal osteotomy in cadaveric specimens resulted in a statistical decrease in plantar pressures over the 1st and 2nd metatarsal regions of the foot. The study also showed a significant increase in pressures over the lateral forefoot. Achilles tendon length was shown to trend toward shortening throughout the tendon. The purpose of this study was to compare the effects of adding a vertical translation of the osteotomy, with the ventromedial portion of the tendon and longitudinally to the calcaneus after translating the posterior aspect of the calcaneus medially by 2 cm, to foot pressures over the plantar surface of the foot in a cadaveric model. We hypothesized that as a result of the MCO, the medial aspect of the foot would experience increased length. Change was expected due to the fact that the tendon is now acting as more of an inverter of the foot due to the repositioning of the posterior aspect of the calcaneus. The results of these studies show that by adding a superior translation to the medial slide, the benefits to foot pressures over the medial forefoot are maintained with resolution of the increased lateral foot pressures present with the MCO alone.

METHODS: Twenty-six fresh frozen cadaveric feet were cut proximal to the knee joint to preserve the origin of the gastrocnemius muscle. Each specimen was thawed overnight at room temperature. Specimens were then potted in PMMA and PVC piping and secured in a custom molded frame. Differential variable reluctance transducers (DVRT) (Microstrain, Burlington, VT) were used to determine changes in elongation patterns of the Achilles tendon. The DVRT’s were inserted in the tendon 2 cm proximal to the posterior tuberosity of the calcaneus in the ventromedial (VM), dorsomedial (DM), dorsolateral (DL), and ventrolateral positions (VL). The specimens were then loaded in the neutral and dorsiflexed (15 degrees) positions for 30 seconds after which DVRT and foot pressure data was gathered. The specimens were then unloaded for 30 seconds and resting data for the DVRT’s was collected. Specimens underwent three consecutive trials for each position tested. After removing the specimens from the load frame, a medializing calcaneal osteotomy was performed on each foot using the classic lateral surgical exposure (4). Cannulated screws were used to fix the osteotomy in place after translating the posterior aspect of the calcaneus medially by 1 cm. Fourteen specimens in the original study underwent the medial slide only. All specimens in the follow up study underwent the medial slide as well with the incorporation of a 0.5 cm superior translation for six specimens with a 1 cm superior translation for the remaining six. Specimens were then re-mounted on the load-frame and DVRT and foot pressure data was gathered for three trials in the neutral cut and dorsiflexed cut positions. The testing protocol followed was identical to that used for the uncut specimens. ANOVA, followed by Tukey-Kramer pairwise comparisons, was performed comparing the data gathered for the uncut specimens to that of the specimens having undergone MCO for each DVRT position. For the purpose of evaluating plantar pressures, the foot was divided into seven separate regions. Foot pressure data was gathered for three trials each foot in both Pre-MCO and Post-MCO conditions. As with the DVRT data, ANOVA and post-hoc comparisons were performed to compare the changes in foot pressures between uncut and osteotomized specimens.

RESULTS: There was a trend toward shortening of the Achilles tendon globally with shortening most evident in the ventromedial aspect. This trend was reproducible in the follow up study with superior translation of the osteotomy, with the ventromedial portion of the tendon experiencing the greatest shortening. The MCO itself resulted in a significant decrease in medial forefoot pressures and a concomitant increase in pressures over the lateral forefoot. The addition of the superior translation maintained the decrease in medial forefoot pressures with a trend toward decreased foot pressures over the lateral forefoot as well.

DISCUSSION: While it was hypothesized that the superior translation of the MCO would cause decreased tension in the Achilles tendon, the more striking finding of the study was the trend toward decreased lateral foot pressures with the incorporation of the superior translation. It was hypothesized that as a result of the MCO, the medial aspect of the Achilles tendon would experience increased length change. This was expected due to the fact that the tendon is now acting as more of an inverter of the foot due to the repositioning of the posterior aspect of the calcaneus. The results of these studies show that by adding a superior translation to the medial slide, the benefits to foot pressures over the medial forefoot are maintained with resolution of the increased lateral foot pressures present with the MCO alone.

Figure 1: DVRT lengths in the Achilles tendon with specimens under 100lbs compressive load for neutral position. A similar trend was noted for the dorsiflexed foot. Significant differences denoted by: *p<0.05.

Figure 2: Average plantar pressure readings with specimens under 100lbs compressive load, according to regions in Fig 3. Significant differences denoted by: •p<0.0001, $p<0.001$, •p<0.01, *p<0.05.

Figure 3: Typical outline of plantar pressure distribution for a left foot and associate region numbering.

REFERENCES:
2 Cavanagh, PR et al. Foot and Ankle. Vol. 7 no. 5 pp 262-276. 1987